

Maryland Energy

ADMINISTRATION

Powering Maryland's Future

Maryland Save Energy Now™

Presents:

**Efficient Lighting Technologies
for the Industrial Sector**

March 3, 2011

Agenda

- Introduction
 - Program Background and Overview
 - Upcoming Events
- Lighting presentation by Jennifer Amann, ACEEE
- Success story from Cambridge International
- Q&A

Note – Slides will be sent to all attendees after the webinar.

Maryland Save Energy Now™

www.energy.maryland.gov/SEN

- *Maryland Save Energy Now™* and other Maryland Energy Administration programs support EmPOWER Maryland - an initiative to reduce per-capita electricity consumption and peak demand 15% by the end of 2015.
- Made possible by funding from the American Recovery and Reinvestment Act (ARRA) of 2009.

Maryland Save Energy Now™

www.energy.maryland.gov/SEN

- An MEA program for the Industrial sector
- Managed by Maryland Energy Administration with partners: SENTECH and the University of Maryland Manufacturing Assistance Program
- Collaboration with Utility partners



Upcoming Events

- Combined Heat and Power seminar:
 - Thursday, March 24
 - 9:30 AM to 3:00 PM
 - at the UMBC Incubator and Accelerator off I-95 near the Baltimore campus
 - more technical detail than the CHP 101 webinar

Utility Lighting Incentives for Commercial & Industrial

Allegheny Power	T-12 to T-8 Upgrade	\$15.20 per fixture.
	HID to T-5 Fixtures	\$25 per replaced HID light.
	Occupancy Sensors (wall plate)	\$25 per sensor.
	LED Exit Signs	\$15 per exit sign.
BGE Refer to BGE website for required minimum watts reduced for each lighting incentive.	T12 to T8 or T5	\$15 per fixture.
	New fixtures	\$35 to \$90 per fixture.
	Occupancy Sensors	\$25 to \$100 per sensor.
	Daylight Controls	\$25 to \$40 per ballast.
	LED Exit signs	\$25 per fixture.
	LED reach-in freezer or cooler lighting	\$25 per door.
	Occupancy Sensors – Reach-in freezer or cooler lighting	\$9 per door.

Summary examples only – for full details, visit each utility website and speak to utility representative.

Utility incentive websites can be found at: www.energy.maryland.gov/SEN/Financing.html

Utility Lighting Incentives for Commercial & Industrial

Delmarva Power/ Pepco For new fixtures replacing existing fixtures.	New T8 fixture	\$25 to \$40 per fixture.
	New Pulse-start Metal Halide	\$35 per fixture.
	Relamp & Reballast existing fixture	\$15 to \$35 per fixture.
	De-lamp/Retrofit Existing Fixture	\$25 to \$60 per fixture.
	Occupancy Controls	\$25 to \$75 per sensor.
	Daylight Controls	\$30 to \$40 per ballast.
	LED Exit Signs	\$25 per fixture.

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Incentives are part of the EmPOWER Maryland initiative.



30 Years of Energizing Efficiency

Industrial Lighting Webinar

Jennifer Amann, LC

Buildings Program Director

March 3, 2011

Overview

- Guidelines for effective industrial lighting
- Lighting Technologies
- Retrofit Opportunities
- Resources
- Incentives

Effective, efficient lighting

- Reduces costs
 - Energy
 - Operations and maintenance
 - Scrap
- Reduces emissions
- Improves productivity
 - Enhanced comfort for workers
 - Fewer mistakes
- Is a moving target!
 - New technologies and strategies can yield 20-50% savings in lighting energy use
 - Savings opportunities exist even in newer facilities
 - Federal standards are driving broad turnover in lighting equipment

Guidelines for effective industrial lighting

Quality: uniformity, contrast, reflectance, limited glare

Quantity: light levels and distribution

Safety: limit stroboscopic effect (flicker), safety colors

Operating conditions: temperature, humidity, duty cycle

Maintenance: lamp dirt depreciation, accessibility

Energy/economic/ergonomic performance

IES RP-7-01 *Recommended Practice for Lighting Industrial Facilities* provides guidance on each factor for a range of industrial applications and activities

Lighting Technologies for Industrial Applications



High-Intensity Discharge (HID)

Typically the most energy-efficient choice in applications requiring: high lamp efficacy, long life, good optical control, good light quality/color, and insensitivity to extreme ambient temperatures

Metal Halide		High Pressure Sodium
20W to 2000W	Wattage Range	35W to 1000W
2700 to 20,000K	Color Temperature	1900 to 2200K
65 to 90+	Color Rendering Index	22 (“deluxe” 65)
65 to 115 lpw	System efficacy (lumens per watt)	70 to 120 lpw
10,000 to 20,000+ hours	Lifetime	

Federal standards for HID lighting

HID lamps:

Pending: HID lamp standards scheduled for publication 06/2012
INCAAA bill includes prohibition on MV lamps

HID ballasts:

01/2008: Prohibition on MV ballasts per EPACT 2005

MH fixtures:

01/2009: minimum ballast efficiency standards for new fixtures

pulse start ballasts = 88%

probe start ballasts = 94%

Pending: DOE must complete rulemaking by 01/2012; revised standards to take effect 01/2015

INCAAA negotiated standards on outdoor lighting

Advanced metal halide: Pulse-start metal halide (PSMH)

Efficacy: 25%+ more efficient than probe-start MH

Lifetime: 50% longer life than probe-start MH with improved lumen maintenance

Reduced warm-up and restrike times relative to standard probe-start systems

Electronic ballasts allow for improvements in efficiency, some dimming capability but still best suited for indoor applications

Bi-level dimming

Limitations: burning position can impact performance, control limitations

Performance of PSMH lamps

Some PSMH and
CMH 85-90+

Electronic ballasts
can increase

Lamp Watts	Chromaticity/CRI (Kelvins/Ra)	Initial Lumens	Mean Lumens	Rated Life (Hours)	Mean Lm/W
50	4000/65	3400	2550	10000	51
70	4000/65	5600	4200	15000	60
	3200/65	5600	4200	15000	60
100	4000/65	9000	6800	15000	68
	3200/65	9000	6800	15000	68
150	4000/65	15000	11300	15000	75
	3200/65	15000	11300	15000	75
175	4000/75	17500	14000	15000	80
	3200/65	16250	12500	15000	71
250	4000/65	21500	16200	15000	65
400	4000/65	44000	33900	15000	85
	3200/65	44000	33900	20000	85

Source: Advanced Lighting Guidelines Online 2011 www.algonline.org

PSMH ballasts

Magnetic

Constant-wattage autotransformer (CWA): good power regulation, modest ballast losses, handle voltage dip variations of up to 45%.

Linear reactor: improved ballast efficiency and lamp performance relative to CWA (up to 35W reduction in input power); only available in 277 volts; very sensitive to power quality and variations in voltage

Regulated lag: most sophisticated design; good power regulation & lumen maintenance; drawbacks of large size, lower efficiency, and higher cost

Electronic

Advantages: reduced size, higher power factor, greater efficiency, cooler operation, improved lumen maintenance and color stability, longer lamp life, and improved dimming capability

Limitations: higher first cost, lamp/ballast compatibility issues, reliability and availability

Current market share less than 10% but growing as lower-cost, non-dimming and dimming ballasts introduced

PSMH Applications

Manufacturing and assembly spaces

Warehouse

Cold storage

Exterior lighting

Parking facilities/areas

Important considerations:

Back up lighting for power outages

Ensure power supply circuits are phased to avoid
stroboscopic effects

Fluorescent lighting

High-efficiency, cost-effective options with growing presence in industrial applications. Wide range of options requires care in selection of appropriate system for given application

Linear fluorescent

- T12: obsolete except in few specialty applications
- T8:** wide variety: energy savers, super T8s, long life
- T5: enhanced optics for some applications, similar energy performance to T8, limited retrofit options

Compact fluorescent (CFL)

Good option for task lighting and in some general lighting applications

Fluorescent technology limitations: poor performance in cold temperatures; glare issues

Federal standards for fluorescent lighting

Linear fluorescent lamps

07/2012: Minimum efficacy standard (lpw) will eliminate most T12 & basic T8 lamps

Linear fluorescent lamp ballasts

2005: magnetic ballasts prohibited in new fixtures

2010: magnetic ballasts completely prohibited

Pending: revised standard scheduled for publication 06/2011 for 2014 effective date

Performance of linear fluorescent lamps

Lamp Type ^a	Nominal Length	Maximum Overall Length	Rated Watts	Rated Lumens ^b	Mean Lumens	Rated Life ^c (Hours)	Efficacy (Lm/W) (Mean)	Avg. Lamp Luminance
F40T12	48 in.	47.78 in.	40	3300	2970 (0.90)	20000	74.3	800 cd/ft ² 8000 cd/m ²
F32T8	48 in.	47.78 in.	32	3100	3000 (0.97)	24000	93.8	1300 cd/ft ² 13000 cd/m ²
F25T8	48 in.	47.78 in.	25	2500	2425 (0.97)	24000	97.0	1000 cd/ft ² 10000 cd/m ²
F28T5	45.8 in.	45.8 in.	28	3050	2900 (0.95)	20000	103.6	2000 cd/ft ² 20000 cd/m ²
F54T5/H	45.8 in.	45.8 in.	54	5000	4750 (0.95)	25000	92.6	3400 cd/ft ² 34000 cd/m ²

^a All lamps are manufacturers' premium-performing products, RE841 color.

^b T-8 and T-12 lamps are rated at 60Hz and 25°C. T-5 lamps are rated at high frequency and 35°C.

^c Rated life at 3 hours/start. T-5 lamps are rated on a high frequency, programmed-start ballast.

Source: Advanced Lighting Guidelines Online 2011 www.algonline.org

Fluorescent ballast terminology

Ballast factor (BF): actual lumen output for specific lamp-ballast divided by rated lumen output measured with a reference ballast
BF ratings allow designers to optimize light output for application
BF < 1.0 Lamp will operate at lower wattage and lower lumen output
BF > 1.0 Lamp will operate at higher wattage and higher lumen output

Ballast efficacy factor (BEF): primary metric of ballast efficiency;
ratio of ballast factor to active power (in watts)

System efficacy: metric of overall performance of specific lamp-ballast combination

System efficacy (lpw) = $\frac{\text{Lamp lumens} \times \# \text{ lamps/ballast} \times \text{ballast factor}}{\text{input power}}$

Fluorescent ballast types (electronic)

Rapid-start

Instant-start

Programmed-start

Two-level (step)

Load shedding

Dimming

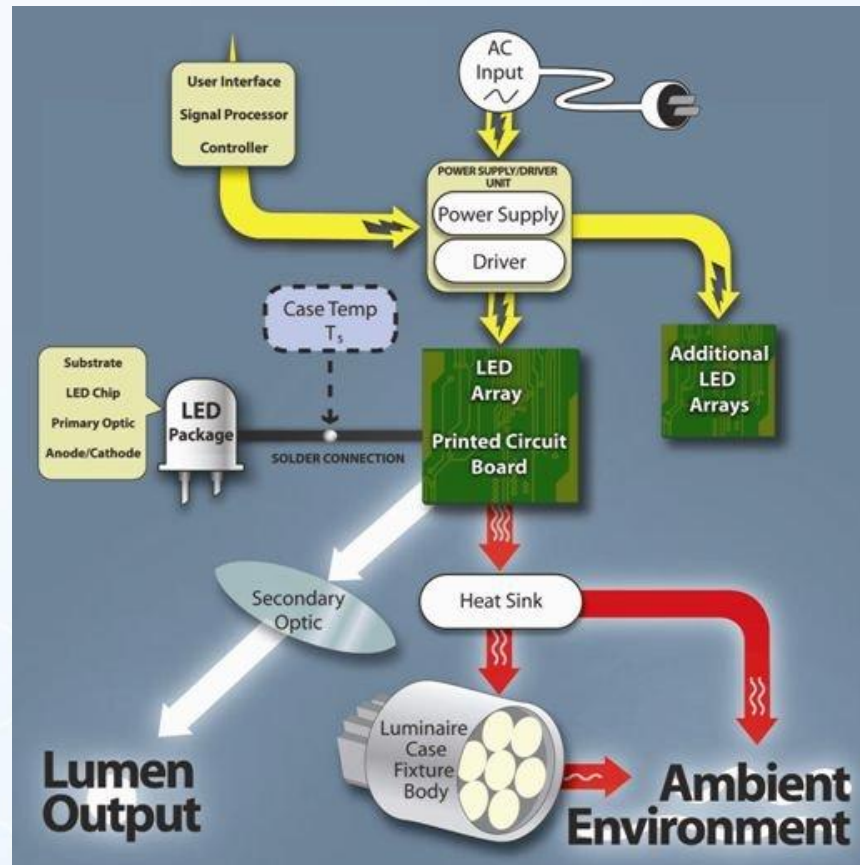
Fluorescent lighting applications

Manufacturing and assembly spaces

Warehouse



Solid-state lighting (LED)



The state of solid state lighting

Lumen output and efficacy on the rise

Prices decreasing

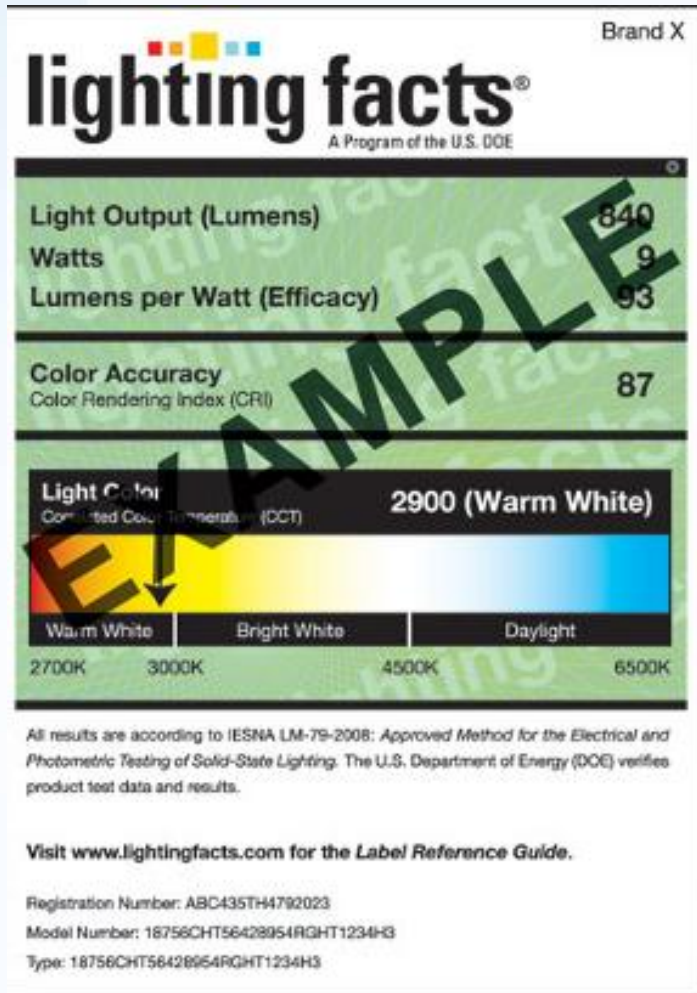
Ideal for many task lighting needs now

High-bay and **exterior** applications among the most promising new developments

Recent testing demonstrates need for additional product development and patience (caution) by buyers

http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/caliper_round-11_summary.pdf

SSL product selection



DOE Quality Advocates Program

- Manufacturers, distributors, retailers, end-users, others
- Pledge to use Lighting Facts label for all products
- Label summarizes results of IES-LM-79 testing:
 - Lumens
 - Efficacy
 - Watts
 - CCT
 - CRI

Disclosure, not endorsement

www1.eere.energy.gov/buildings/ssl/advocates.html

Sensors & Controls

Switching (on/off):

Time clocks

Scheduling

Occupancy/vacancy

Dimming:

Daylight harvesting

Load shedding

Adaptive compensation

Lumen maintenance

Bi-level or step

Recommended Controls by Space Type

Ask this about the application:	If YES, consider this strategy:
Is occupancy unpredictable? (e.g., unpredictably unoccupied for over 30% of the time; restrooms, stock rooms, warehouse aisles, hotel rooms)	Occupancy sensing Timer switches
Is space use highly predictable and not a 24-hour, 7-day operation?	Scheduling
Is exterior lighting used for facades, signage or parking areas?	Photosensors Scheduling Occupancy sensors
Is daylight available from windows or skylights?	Photosensors (automatic switching or dimming) Manual dimming Bilevel and multilevel switching Time switches
Is there a need to vary light levels during day or after hours?	Manual dimming Bilevel and multilevel switching Adaptive compensation (nighttime light level reduction via scheduled dimming)
Does the space have many different uses (e.g., conference room, ballroom)?	Multiscene control Manual or automatic dimming Bilevel and multilevel switching
Is there a lot of churn or turnover in the space (open office)?	Manual or automatic dimming Bilevel and multilevel switching

Daylighting

- Sidelighting, Toplighting
 - Windows
 - Skylights
 - Clerestories, monitors, sawtooths
 - Light pipes and tubes
- Considerations
 - Light levels
 - Ceiling plane/orientation
 - Glare
 - Heat gain
 - Interaction with lighting system

Retrofit Opportunities

Best opportunities

- Upgrading to more efficient technologies
- Updating fixtures and introducing task lighting
- Installing and properly commissioning controls
- Daylight harvesting
- Avoiding over-lighting and lighting of unoccupied spaces (through delamping and controls)
- Turning off exterior lighting during daytime hours
- Using dimming and automatic on/off controls appropriately

HID Upgrade: Probe-start MH to Pulse-Start MH



MH to PSMH Retrofit Options

- A) 1-to-1 fixture replacement
- B) Reduce total # of fixtures

	Existing	Option A	Option B
# of fixtures	75	75	50
Lamp & ballast	400W MH	320W PSMH	400W PSMH
System wattage	455	349	435
Initial lumens	26,670	23,622	30,480
Mean lumens	16,002	17,717	22,860
Total wattage	34,125	26,175	21,750

Additional opportunities for savings:

Bi-level dimming (typical hours: 15% high-level/85% low level)

Aisle-lighting fixtures can reduce fixtures needed

Electronic ballasts (in Option B: 44 fixtures and 18,920 total watts)

MH to fluorescent conversion

Applications:

Warehouse Lighting

High-bay Industrial

Low-bay Industrial

Benefits:

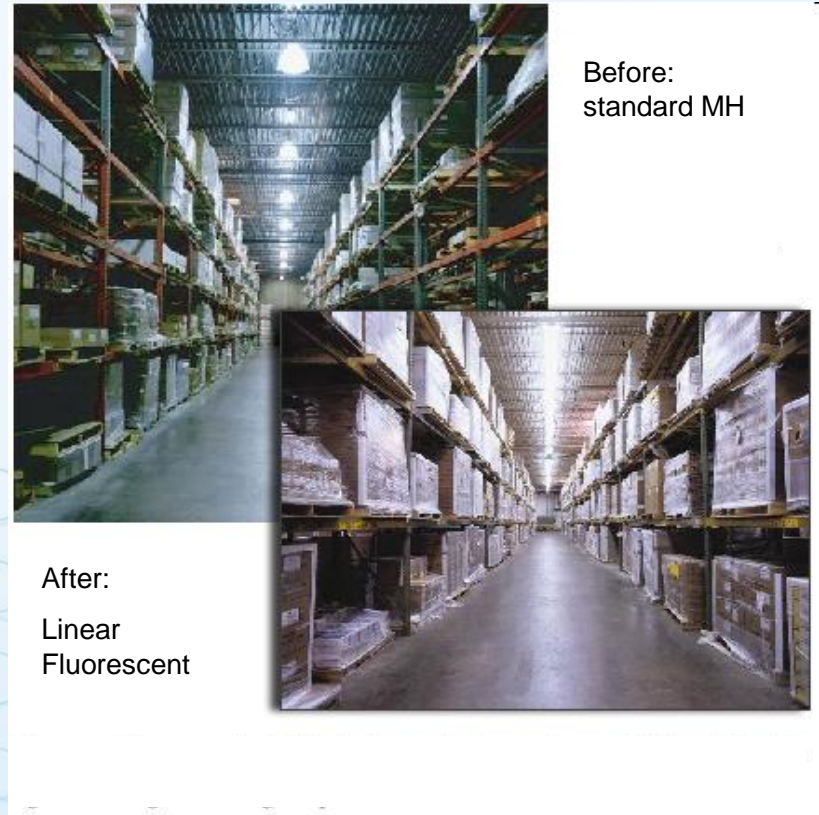
Control capabilities

Maintenance

Lamp stocking consistency

Limitations:

Cold temperature



Warehouse case study

Project details:

124,000 square feet

120 hours/week operations

	Existing	Retrofit
Horizontal fc	20 (5-15 in some areas)	25 uniformly
Lamp	400W MH	6 x 32W 2 x 32W
LPD	0.67 watt/sf	0.36 watts/sf
kWh/year	468,000	120,000
Annual cost	\$72,000	\$18,000

Existing System

175 MH

30 ft. mounting height

Skylights

New System

32W high-performance T8

54 high-bay 2'x4' fixtures (1.15 BF)

508 8' linear fixtures (1.0 BF)

Occupancy sensors

Photosensors

75% energy cost reduction

1.2 year payback

Reduced employee errors

Annual carbon emissions credit

MH to fluorescent conversion

	400W MH (1 lamp)	32W High-perf T8 (6 lamp)	54W T5HO (4 lamp)	54W T5HO (6 lamp)
Initial lamp lumens	36,000	18,600	20,000	30,000
Ballast factor	1.0	1.18	1.0	1.0
Initial system lumens	36,000	21,948	20,000	30,000
Mean system lumens	23,500	20,851	19,000	28,500
System watts	458	222	216	324
% wattage reduction	--	52%	49%	23%
Efficacy: Initial (Maintained) (lpw)	79 (51)	99 (94)	85 (81)	85 (81)
Lumen maintenance	65%	95%	95%	95%
Color rendering (CRI)	65	85	82-85	82-85
Lifetime	20,000	28,000	24,000	24,000

SSL area lighting (campus street and parking)

Baseline luminaire

128W HPS system

Bi-level LED luminaire

118W

Occupancy rate

60% high mode/40% low mode

(expect 32% high/68% low for parking areas)

Energy savings

32%

Maintenance savings

20%



Exterior lighting: Bi-level HID wallpack



Pre-retrofit

150W HPS

Low efficiency

Poor light quality

Minimal cutoff

No occupancy response



Post-retrofit

150 W PSMH

Improved light level/quality

Reduced light pollution

100%/50% bi-level occupancy response

42% energy savings

(9% occupancy)

Resources

Resources

IES Lighting Handbook, 10 edition pending for 2011 publication

IES RP-07-01 *Recommended Practice for Industrial Lighting*

ANSI/IES RP-08-2005 *Standard Practice for Roadway Lighting*

ANSI/IES RP-20-2007 *Lighting for Parking Facilities*

IES G-1-03 *Guideline for Security Lighting for People, Property and Public Spaces*

IES RP-5 *Recommended Practice of Daylighting*

Advanced Lighting Guidelines, online resource (\$95/year subscription): www.algonline.org

ASHRAE/IES Advanced Energy Design Guide: Small Warehouses and Self-Storage Buildings (free download):
www.ies.org/store/AEDG.cfm

DOE Solid State Lighting program resources: www1.eere.energy.gov/buildings/ssl

Daylighting Collaborative: www.daylighting.org

SkyCalc: www.designlights.org/skylighting.about.php

Lighting Research Center, Rensselaer Polytechnic Institute, Demonstration and Evaluation of Lighting Technology and Applications (DELTA) field test case studies: www.lrc.rpi.edu/programs/DELTA/publications

California Lighting Technology Center: www.cltc.ucdavis.edu

National Electrical Manufacturers Association: www.nema.org

Thank You!

Jennifer Amann, LC

202.507.4015

jamann@aceee.org

Cambridge-International

A lighting Journey

Chad Scheve

(410)228-3007 ext. 2454

cscheve@cambridge-intl.com

<http://www.cambridge-intl.com>

Introduction

- World's largest metal belt manufacturer
- Five manufacturing facilities. Three domestic and two international; approximately 300 employees
- Celebrating our 100 year anniversary in 2011
- Metal conveying belts, Environmental Systems, and Architectural Mesh are our three brands.
- Our domestic production facilities process ~ 10MM pounds of wire and strip

Business Case

- In our MD facilities we use ~ 1.476 MM kwh/year.
- Safety and Quality were two focal points in these facilities.
- Previous lighting was 30+ years old.
 - Ballasts and fixtures were failing and only ~ 70% effective.
 - Average foot candles ranged from 9 – 19 fc's
 - New fixtures/system bring us to appropriate standards for manufacturing with a range from 42 – 72 fc's.
 - This was achieved while reducing the fixtures in half

Before



After



Financial Impact

- Energy reduction
 - Saved over \$72k annually with an ROI of under 4 years.
 - Energy KWH reduced is ~ 828k or 56% reduction.
- 50% reduction in maintenance costs on upkeep
- \$1500 reduction in bulb replacement/year

Environmental Impact

- Reduction of KWHs is equivalent to:
 - 551 tons of removed CO₂/year
 - 152 acres of trees planted/year
 - 134 cars removed from the road/year
 - 68,421 gallons of gas saved/year
- These reductions allow CI to continue to be environmentally responsible by supporting reductions in global warming, acid rain, and smog (air pollution).

Quotes

- “The new lighting has allowed us to see inside our machines during setups”
- “Since the lighting has been installed in the last 3 months we have not had to replace any bulbs, while with the old fixtures we would’ve had to replace them twice by now”
- “The new lights allow us see the material during our quality checks, previously we would’ve had to hold the material up to the light. Now it doesn’t matter where it is in here because the light is consistent all around”



Question & Answer Session

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